

REMARKS:

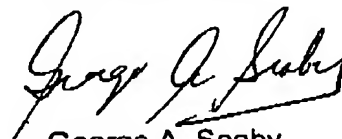
The above amendments are believed to deal with each of the issues raised in the Official Action under reply. Specifically, the specification has been amended to ensure that there is proper antecedent basis for the claim limitations found in claims 5, 12 and 14. The errors in claims 8 and 20 pointed out by the examiner have been corrected, and the claims have been amended to overcome the 35 U.S.C 112 objections and to patentably distinguish the invention from the prior art of record.

Concerning the obviousness rejection of some of the claims, it will be noted that new claim 22 contains the limitations listed in paragraph (19) of the Official Action under reply. Claim 22 has not been limited to chloride salts, since such a limitation would unduly limit the scope of protection to which applicant is entitled. It would be readily apparent to one of ordinary skill in the art that other platinum and ruthenium salts could be substituted for the chlorides specially listed in the specification.

The remaining claims in the application are directly or indirectly dependent on claim 22, and accordingly are believed to be allowable over the prior art of record.

Early and favourable reconsideration of this application is requested.

Yours sincerely,



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by methanol pretreatment of the support. Prior to Co-Ni deposition, the carbon backings were pretreated with methanol for 30 min, in order to improve the homogeneity of the Co-Ni particle sizes and their distributions on the carbon fibers of the backing. Details of Co-Ni particle deposition were described previously [X. Sun et al, *Chem. Phys. Lett.*, **363**, 415 (2002) and X. Sun et al, *International Journal of Nanoscience*, **1**, 223 (2002)]. As illustrated schematically in Fig. 1, an important step in the fabrication of the MWCNTs is the use of a commercially available silane derivative 2(4-chlorosulfonylphenyl) ethyl trichlorosilane available from United Chemical Technologies which, upon hydrolysis, forms a sulfonic acid-silicate, permitting the exchange of H^+ for Co^{2+} and Ni^{2+} ions. The latter ions are the precursors of the Co-Ni particles. Platinum deposition on nanotubes and the carbon paper substrate was effected using the same silane derivative, but using Pt^{2+} ions as Pt particle precursors.

In the present case, a metal selected from the group consisting of platinum, palladium, titanium, ruthenium, gold, nickel, cobalt, silver, manganese, molybdenum and alloys thereof is deposited on the MWCNTs using a silane derivative.

Example 1

In a preferred embodiment of the invention, Pt is deposited using 2(4-chlorosulfonylphenyl) ethyl trichlorosilane and platinum chloride. The MWCNT/carbon paper composite was immersed in a solution containing 0.04M $PtCl_2$, 1 vol % silane derivative and 6 vol % water in ethanol. The composite structure was then dried at room temperature and reduced in a stream of $H_2 + Ar$ at 550 - 600°C and preferably 580°C for 15 minutes. The 30 minute methanol pretreatment of the

800°C under $H_2 + Ar$ for 10 min, or (iii) Immersion in concentrated $H_2SO_4 + HNO_3$ (50:50 vol) at 140°C for 5 min or (iv) treatment with 70% nitric acid for 2 to 20 hours. Pretreatments (ii) and (iii) give a larger density of Pt-Ru alloy nanoparticles than pretreatment (i).

- 5 PtRu alloy was deposited on a MWCNT/carbon paper composite by immersing the composite for 2 hours in a solution containing 0.04 M $PtCl_2$, 0.04 M $RuCl_2$, 1 vol% of sulfonated silane, 6 vol % water and ethanol. The concentration of the chloride(s) is sufficient to give a concentration of at least one of Pt and Ru of 0.2 to 2M. The composite was then dried at room temperature and reduced in a flow of
- 10 $H_2 + Ar$ at 580°C for 15 min before examination by HRTEM. Figure 5 is a typical HRTEM image showing deposits of PtRu particles. The tube has an outer diameter of nearly 25 nm with a hollow (inner diameter) of about 13 nm. The walls of the tube consist of about 15 cylindrical graphene layers. Nanoparticles are clearly seen to decorate the MWCNTs and they are evenly distributed over the walls of the tubes.
- 15 The particles are located only on the external surfaces of the tubes, because the tubes were not opened by the pretreatments, even the short immersion in concentrated $H_2SO_4 + HNO_3$. The particle size distribution is quite narrow, with an average size of less than 1.5 nm.